

Plotter with floating motor scans 40 in./s within 0.001 in.

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Just another X-Y plotting system, you say. Not so! This one is special—it is really unique.

The ADS-1 is an automatic drafting system that can operate at speeds of 40 inches per second while achieving a resolution of ± 0.001 inches. In reality, the operating speed of this amazing system is limited only by the control pulse rate and the pen ink flow.

How is it done? The answer is simple; it's all in the motor. The ADS-1 incorporates a revolutionary two-axis motor design that is the result of a newly patented concept called the Sawyer Principle. To simplify matters, let's first look at how single-axis operation is controlled.

The basic elements are: a magnet assembly, called a forcer, which consists of a permanent magnet connected to two electromagnets; and a completely passive platen or toothed base that is made of a fer-

romagnetic material. The forcer floats above the platen as shown in the figure below.

The permanent magnet produces an equal flux in all four pole tips of the electromagnets. Flux in pole tips 1 and 2 is opposite in polarity to that in 3 and 4.

Electromagnet A is now on and electromagnet B is now off. When an appropriate current is applied to B, it induces an additional magnetic force at pole tips 3 and 4. The forces at 3 add, while those at 4 cancel.

The forcer now has a new preferred position as shown by the flux lines, and will move to the left. Energizing electromagnet A so that pole tip 2 has an additive force will continue motion to the left. To complete a full cycle to the left, B is energized again (4 contributes) and then A (1 contributes).

Four flux changes result in a linear displacement that is equal to the pitch of the toothed base. Movement to the right can be initiated by first energizing 4.

The complete motor in the plotting system uses two forcers align-

ed at right angles to each other and combined into a single assembly. The platen is cross-scored to form equi-distant rectangular islands of equal size and height.

The scorings are filled with a non-magnetic material to provide a smooth surface. The forcer assembly is then supported on the platen by a stable airbearing.

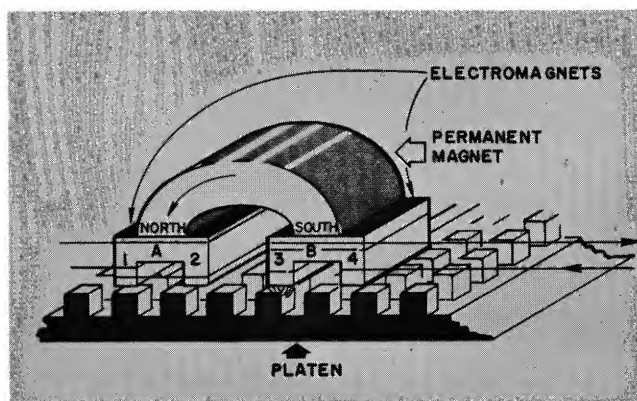
However, because of the airbearing and waffle-iron characteristics of the platen, the motor is not restricted to only axis-parallel movements. It can move in any direction that is the vector resultant of two orthogonal commands.

To obtain its 0.001-inch resolution, the ADS-1 uses two d/a resolvers. These continuously control position by supplying a current to electromagnet A that is a cosine function and a current to electromagnet B that is a sine function.

By incrementally controlling the phase of the electromagnet current drive, the resolvers move the head 0.001 inch for each command. There are a total of 40 incremental steps to move through one full pitch of the platen as shown on the oscilloscope face below.

Each digital-to-analog resolver consists of a 10-state up-down counter, sign logic, analog switches and a ladder network.

Booth No. 21004 Circle No. 357



Sawyer Principle motor design allows new X-Y plotting system to draw at 40 in./s. A permanent-magnet/electromagnet assembly simply skims over a toothed base.

Scope trace of d/a resolver output shows Lissajous pattern of 40 incremental steps for one full motor cycle.

